

Michigan State University CCU (Control and Concentrator Unit)  
Information for Safety Review for LAPD.

#### Introduction

The MSU Control and Concentrator Unit (CCU) is a 48-channel device to control scintillation counters using the Hamamatsu H5783 photomultiplier module coupled with the MSU Photomultiplier-tube Amplifier and Discriminator (PAD). This system was used previously to control 144 TSU counters and approximately 500 other counters in the CDF-Run-II detector. A publication "Gain and Threshold Control of Scintillation Counters in the CDF Muon Upgrade for Run II, C. Bromberg in Proceedings of the APS DPF conference DPF2000, Columbus, Ohio, Aug. 2000, gives a general description of the MSU trigger counter system that has been installed in PC4 around the LAPD cryostat. There are 48 TSU counters being controlled by one CCU.

For details of the electronics, the schematics for both the CCU and PAD circuits are attached to this document. Each CCU module has 4 internal commercial power supplies, which are fused at their inputs (-11V, +15V, +5V, -7V) and have on board over-current protection on the outputs.

During deployment at CDF it was shown that the distributed DC powered counters are fused or have some other current limiting feature to prevent any short circuit on the counters from causing a fire. On a Cat5 cable (AWG bare copper conductors rated at 0.3A) to each TSU counter, the CCU distributes digital control and counter signals as well as ground and two DC voltages, +12V and -5V. Schematic pages 14-16 show the +12V supplied by a regulator (LM78L12ACM), while the -5V (-VIN) supplied by a regulator (LM79L05ACM). The data sheet for the regulators list as features:

- \* Output current of 100 mA
- \* Internal thermal overload protection
- \* Output transistor safe area protection
- \* Internal short circuit current limit

Both regulators, with a maximum output current of 0.1A and thermal overload protection, as well as the Cat5e cable don't pose fire hazards in the CCU or at the PAD circuits in each counter. The sealed H5783 photomultiplier module generates internally its photomultiplier HV from the +12V supply and therefore the high voltage poses no safety hazard. Also, as shown in the published document, the counters are completely encased in a 20-mil thick aluminum shell, which prevents direct ignition by an external flame.

The next section contains a dialog describing the CCU and PAD schematics, and power supply circuitry and ratings.

Dialog to accompany CCU schematics pdf file.

Each CCU contains two PC boards, one on top of the other, each of which controls 24 PADs

Pages

- 1-10 Digital RS232 communication for the 24 PADs setting the internally generated PMT HV and discriminator threshold, including sensing of PAD current to initiate download. Also, DC filter capacitors for -5.2V (page 7)
- 11-13 Front panel RJ45 connector (24 per board) with 8 wires:  
PD+: +12V; PD-: -5V power; PS, CLK, SD, are RS232 lines to PADs, CH+/-: ECL signal pair from PAD; GND: ground.
- 14-16 Power supply regulators, one for each of 24 PADs, two voltages +12V and -5V.
- 17-20 PAD ECL signals are received, converted to TTL, stretched to 60 ns, reconverted to ECL and output to one 25 pin pair connector for each board.
- 21 PAD circuit board schematic
- 22 Programming interface and Data Download for the CCU Single Board Computer.
- 23 -2V supply circuitry (See below)

Power supplies (note from Barry Tigner, MSU designer of the CCU):

The -2V power supply is powered from a -5V 8A supply with a built-in current limit. It uses a linear adjustable regulator with a transistor current booster. The linear regulator has current and thermal limiting built in. If remember correctly we needed 3A at -2V (for ECL bias voltages), however there was no TO-220 adjustable part available at that current. Here is how the circuit works.

For currents under 700mA, the linear regulator supplies the current. When the current starts going above that, the power transistor starts to conduct to supply the additional current. The -2V regulator circuit has (2) 1 ohm 5 watt wire wound resistors.

The other power supplies are designed with built-in current limits. We checked and adjusted the DC voltages.

- +5V @ 3A powers the SBC and both CCU boards (TTL and ECL).
- 5V @ 8A Power both CCU boards (ECL), and the -2Vregulator.
- +15V @ 3A (adjusted to +14.5) supplies power to the +12V PAD regulators which are current limited devices.
- 15V @ 3A (adjusted to -11.5) supplies power to the -5V PAD regulators which are current limited devices.

The DC power traces on the CCU boards should be 0.05 inch wide 2 Oz copper. All the signal traces should be 0.01 or possibly 0.016 traces.

**The DC wiring used 20 or 22 AWG wires.**

The max currents used by each CCU board depends on how many PADs are connected.

Pads draw +12V@30mA with the PMT running, and -5V@5mA.

A single board supplying 24 PADs would therefore draw 720mA @12V and 120mA @-5V.

In a CCU with both boards supplying 24 PADs, these currents are doubled.

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